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UNIVERSITY TECHNOLOGY PLATFORM OF ANTICIPATORY LEARNING

The innovative development sets large-scale and challenging tasks, which need to be addressed in the lack-of-knowledge conditions and require the coordination and integration of numerous expert structures, which are scattered around the world and have different status and competencies. One of the mechanisms of integrating the partners' intellectual and financial resources is provided by the technology platforms. The article discusses the nature and functions of technology platforms and analyzes the experience of their application in different countries with a special emphasis on universities. The article gives an overview of the various interpretations of technology platform concepts. It also describes the development and implementation of the technological platform at the Ural Federal University (research and education centre 'ENGEC'), which was targeted at organizing anticipatory learning in the sphere of energy engineering and high-tech industries; its mechanism and role in improving different university activities and processes are shown. This platform is based on the original methodology 'Integrated System of Consulting, Training, and Transformation' (ISCT), which includes authentic methods and technologies, which are used in the educational process. A significant advantage of this methodology is that it can be applied in university education as well as in corporate training integrated with innovative activities.

Keywords: technology platform, open innovations, university, expert interaction, network partnership, innovation center, interdisciplinarity, knowledge transfer, methodology, anticipatory learning

Introduction

A technology platform (hereinafter referred to as 'TP') is a way of organizing interaction (including virtual) of various participants (business structures, universities, governmental authorities, independent experts) to solve exceptionally challenging problems, as a rule, from the sphere of science and technology. TP participants are connected through one integrated information infrastructure, which provides the high dynamics of communication and has one common research methodology[1]. The problems addressed within TP are always unique, new, nonlinear, and are characterized by a lack of knowledge, especially those of an interdisciplinary nature, and by an almost total absence of necessary analytical data.

The notion of 'technological platforms' gained popularity in the 1990s and 2000s due to the growing need to intensify the innovative development and formation of the advanced technologies market in the European Union, which was likely to determine their economic and technological leadership for many years to come. The first TP was created in 2001 to organize and coordinate the process of cooperation of European aircraft building companies and the academic community in the sphere of aeronautics research programs. Nowadays, there are about forty platforms in Europe, engaged in studying the questions of hi-tech development: in such areas as a heavy engineering, power engineering, aerospace industry, telecommunications sector, bioeconomics, and transport [1–3].

In Russia, there are over thirty TPs, many of which are focused on the development of new technologies within the framework of one industry, but there are also some interdisciplinary platforms (for instance, 'Bioenergetics' or 'Modelling and Technologies of High-Tech Systems Application') [4]. TPs are supposed to address the following key tasks of the Russian economy:

— identifying opportunities for technological modernization of the real sector;

— encouraging innovations, promoting cooperation in research and production, and establishing new partnerships in the field of innovative development;

— improvement of the industry-specific and legislative regulation for faster spreading of advanced technologies [5].

TPs also contribute to the development of 'knowledge specialization' in the regions. 'Knowledge specialization' is understood here as a choice of such industries on the regional level, which would maximize a TP's contribution to the economic development [6]. 'Knowledge specialization', however, does not necessarily have to be associated with high-tech industries and priority

[1] Sometimes technology platforms are called network platforms to emphasize their main purpose, which is the creation of communication relationships.

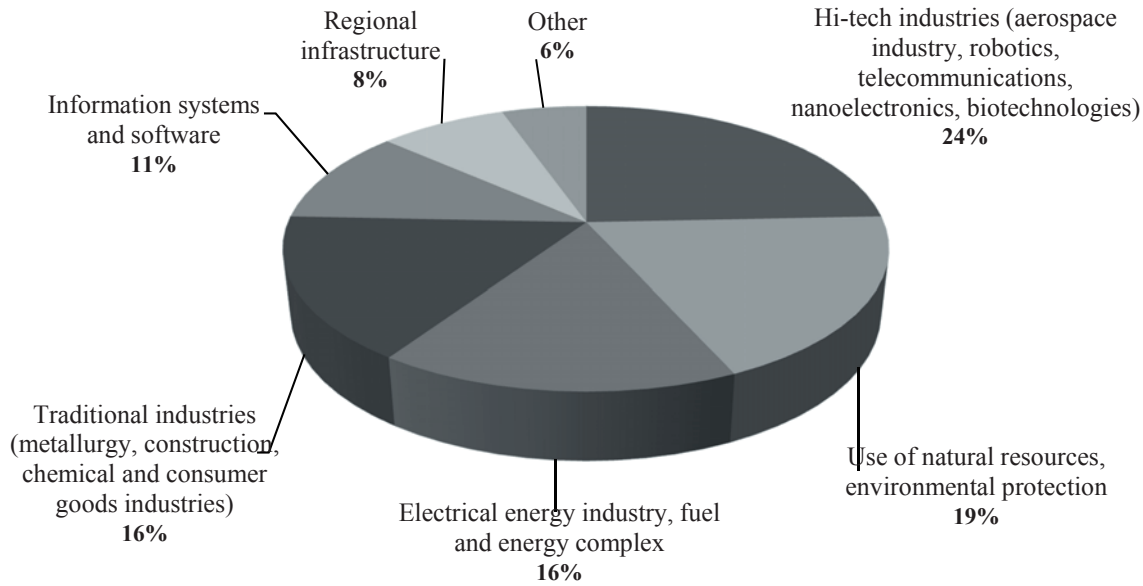

Fig. 1. *Structure of European Technology Platforms*

areas; it could also be the service sector, but only provided that investments in a research within these TPs enhance the region's innovative development and promote the development of other economic sectors.

Platform technologies allow to find a common ground of different geographic markets. International corporations consider technology platforms as a way to centralize services in the region, as well as a base for further company expansion on the local level. For example, Oracle, a world-known manufacturer of software has developed the policy of creating so-called regional hubs in promising areas united in a single platform. The idea is to employ specialists who later would work on the ground in countries that now are serviced remotely. Thus, technology platforms provide a potential basis for future investments in the regional development of the large business[1].

Large businesses tend to be the driving force behind the foreign TPs in any industry, which is proven by many authors conducting research in the sphere of technological platform construction [6–9]. In the European conception, the mechanism of a TP's operation implies the leading role of the industrial sector and that all the participants will join efforts and focus on the innovative projects, which seem to be the most promising from the point of view of demand[2]. TPs also presuppose management of the whole life cycle of the development and manufacturing of innovative products. Thus, TPs are based on the 'bottom-up' principle.

In Russia, TPs, on the contrary, were created according to the 'top-bottom' principle. That is, they tended to be started and managed by large state corporations, which meant that initially providing a rationale for investment granted by the state to conduct research was of higher priority than the commercialization of innovations.

Classification of Technology Platforms

The average structure of European TPs (Fig. 1) according to the types of participant organizations shows that the real sector companies (45 %) predominate although the share of research institutions and universities is also quite large (about 40 %). Other stakeholders include:

— financial sector (private banks, venture funds, institutes of public funding of research and development);

— civil society (consumer organizations and associations, labour unions, self-regulating organizations, and so on);

— public sector (federal authorities, state corporations, regional and local authorities) [1, 6].

Depending on the problems, TP has to handle several different types of partnerships:

— partnership of universities and research organizations;

— partnership of universities, research institutions, and business;

[1] Retrieved from: http://www.ey.com/Publication/vwLUAssets/Globalization_RU/$FILE/Globalization_RU.pdf (date of access: 11.11.2015).

[2] Overview of Technology Platform Strategies. Progress Report for Positioning Arizona for Success in the Biosciences. Retrieved from: http://www.flinnscholars.org/file/final_overview_report_on_technology_platforms_v2_907.pdf (date of access: 11.11.2015).

— partnership of universities, research institutions, industries, financial institutions, and the state.

Each of these types can be realized in three forms.

1. Regional. Regional forms usually imply a partnership of large companies with small and medium enterprises of a specific region, sometimes also involving universities, which are united into territorial clusters. Regional TPs are focused on the developing strategies of innovative development for specific areas, on the developing mechanisms of regional competition, and on the enhancement of innovative entrepreneurship[1].

2. National. In this form, TPs involve participants from different regions and introduce the advanced projects of innovative infrastructure, which make it possible to provide the integration of state, science, and business, and concentrate resources on priority areas of the country's research and technological development [2].

3. Cross-national. When the platform involves the best specialists in this or that field of knowledge from different countries and is orientated towards the creation of cutting-edge technologies, which can affect the future of the whole of mankind.

An interesting case in the development of international TPs is the European centre 'Holst', which is an independent research and development (R&D) corporation and has its own TP[2]. The centre, which has its headquarters in the Netherlands and Belgium, unites 220 specialists from 25 countries, including sixty resident researchers from universities and industrial sectors. The centre applies a strategy of open innovations and focuses on the development of multifunctional technologies (in particular, wireless sensors and flexible electronics), which take from three to ten years to enter the market[3]. Mechanisms of granting rights to intellectual property depend on partnership conditions, characteristics of the product, participants' contributions, and the application of the accumulated experience. New members pay a fee for the right to access the Centre's intellectual property and are granted a non-exclusive license to use the main product and the accompanying innovative products created with their participation. The most active participants are considered to be 'co-authors of the invention' and are entitled to the issuance of sublicenses [10].

The example of Holst is unique because it is a mixed form of partnership between the state and private entities. The Centre's initiatives are supported on the level of specific municipalities and regions of participant countries as well as on the level of national governments.

Sometimes technology platform are centered around a corporation that acts as a system integrator, unites suppliers of innovative business models, services (Table 1).

Despite the fact that this classification is spread mainly in the digital industry, it should be noted that cooperation of keystone firms with universities plays a key role in its long-term competitiveness.

The Role of Universities in the Development of Technological Platforms

An acceleration of knowledge transfer between universities and the real sector has been a steadily developing trend all over the world, which manifests itself through:

— the growth in the number of patents obtained by universities every year;

— the growth in the number of universities of an entrepreneurial type;

— the growth in the number of university spin-offs;

— the growth in the amount of investments provided by enterprises and the share of business in the university capital.

Transformations in R&D models in corporations (from centralized R&D functions to R&D divisions assigned to specific products or businesses) have led to a significant change in the nature of the relationships between universities and business [12, 13]. If in the late twentieth century companies favoured a greater number of connections with various individual researchers, then nowadays, businesses seek to have a limited number of partnerships with university structures[4]. This trend is essential when analyzing the place and role of universities in TPs.

As it has been pointed out above, the university is a key structural element of any TP. Nevertheless, on its own, it seldom acts as a commissioner of platform creation. An exception to this rule was

[1] Retrieved from: https://www.ptj.de/index.php?index=543 (date of access: 11.11.2015).

[2] Retrieved from: http://www.holstcentre.com/about-holst-centre/holst-centre-in-a-nutshell/ (date of access: 11.11.2015).

[3] It should be pointed out that the Holst's business model is based on the two fundamental principles: a) fast reaction to the essential current trends and b) expansion to new, dynamically developing markets. Thus, it can be concluded that the commercial effectiveness of TPs depends on their being targeted at creating new market segments and winning leadership positions.

[4] A vivid example is Rolls-Royce Holdings manufacturing aircraft engines and uniting 300 small university partnerships in 28 large research centres.

Table 1

Classification of technology platforms on the basis of "keystone firm" [11]

Classification Criteria	Internal Platform	Supply-Chain Platform	Industry platform
Level of analysis	Firm	Supply-chain	Industry ecosystems
Platform's constitutive agents	Firm and its constituent sub-units	Assembler; suppliers	Platform leader; complementors
Coordination mechanisms	Authority through managerial hierarchy	Contractual relations between supply-chain member organizations	Ecosystem governance
Examples	Black and Decker (machine tools) Sony Walkman (consumer electronics)	Renault–Nissan (automotive manufacturing) Boeing (aerospace manufacturing)	Facebook (social networking) Google (Internet search and advertising) Apple (Mobile)

Table 2

Closed and open model of innovative development

Comparison Criteria	Closed Innovations	Open Innovations
Talent localization	Inside the organization	Internal talents + attraction of talents from outside
The status of R&D	Inside the organization: from the idea to the final product	External in relation to the organization Internal projects are just a part of the innovation process
Attitude to market leadership	Organization which is the first to bring the innovation to the market wins	It is more profitable to create the best business-model than to be the first on the market
Attitude to intellectual property	Competitors should not make profit on our ideas	Mutually beneficial exchange of intellectual property with the external world

the University of Manchester (UK)[1], which managed to create a global TP uniting such transnational corporations as Astra-Zeneca, IBM, BP, Syngenta, and others.

The TP created by the University of Manchester is a kind of partnership of international interest. Moreover, apart from the obvious advantages (for example, commercialization of innovations), it allows its participants:

— to draw income from creating intellectual property and knowledge transfer;

— to develop competencies of their staff;

— to open new forms of exchange of views and experience, conduct an in-depth analysis of social, political, and economic trends affecting business, and so on.

Nevertheless, the first step in the establishment of this TP was made by the business. Syngenta, a large international manufacturer of agricultural fertilizers and chemicals, since 2007, has set a priority task of developing cooperation with universities. In a comparatively short span of time, it established six so-called innovation centres[2] in research universities in the UK, China, and Australia. The partnership has allowed this company to intensify its work on creating open innovations. Most importantly, this resulted in elaborating a long-term strategy to develop new technologies and target markets for them (Table 2, Fig. 2).

It is worth emphasizing that, according to the Western point of view, universities in TPs are not only researchers and developers of new technologies for the specific business purposes, but they also must be designed as an efficient business model for commercialization of these technologies. If these two conditions are not met simultaneously, the technology platform is considered non-viable.

Therefore, neither simple partnerships between universities and enterprises based on knowledge transfer, nor more complex structures like technoparks are technology platforms, although they may constitute an important part of them [7]. Maintaining the balance of supply and demand, that is, having customers and clients among the platform participants for new specific products and technologies is one of the core principles of establishing TP[3,4].

[1] Retrieved from: http://www.manchester.ac.uk (date of access: 11.11.2015).

[2] A university innovation centre is a structure, which allows to mobilize the efforts of the critical number of researchers to develop the groundbreaking business opportunities, for example, by establishing TPs.

[3] Technology Platforms: From Definition to Implementation of a Common Research Agenda. Report Compiled by a Commission Inter Service Group on Technology Platforms. Retrieved from: ftp://ftp.cordis.europa.eu/pub/etp/docs/report-defweb_en.pdf (date of access: 11.11.2015).

[4] Monash University Technology Research Platform. Retrieved from: https://platforms.monash.edu/matf/images/stories/footer/monash-technology-research-platforms.pdf (date of access: 11.11.2015).

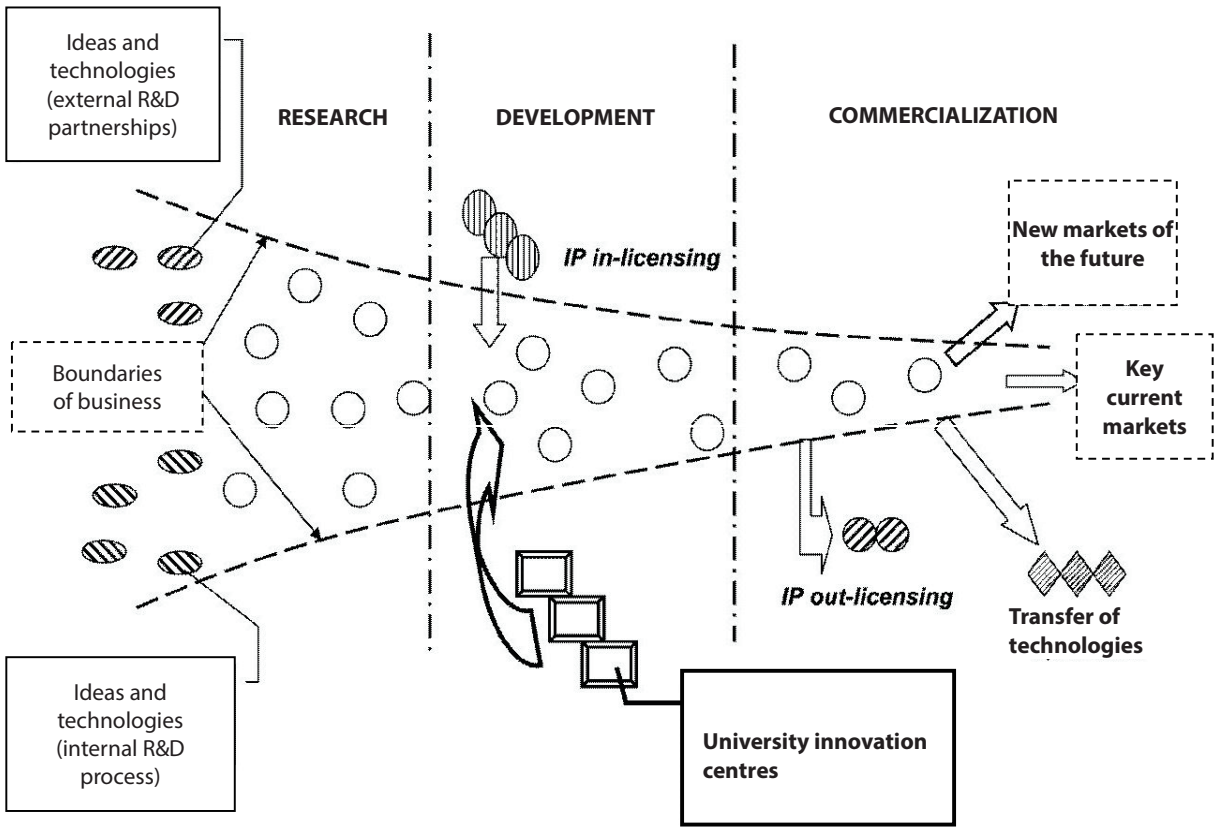

Fig. 2. *University innovation centres are a key element for the strategy of open innovations of hi-tech business*

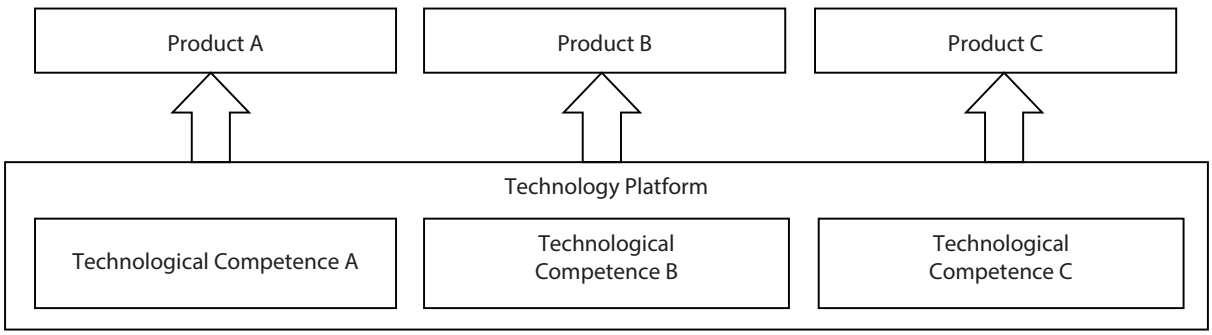

Fig. 3. *TP in terms of product paradigm [8]*

In support of this thesis, it is appropriate to give one more interpretation of TP, according to which the TP concept may be viewed as the technology-related aspects of core competency and dynamic capability. The core competences are knowledge sets that may be leveraged in different products, and that provide an organization with a competitive advantage (Fig. 3).

The structures like university innovation centres are never thought of as a mere addition to the existing corporate competences of business. For business, a partnership with universities means primarily the expansion of its technological potential. At the same time, for universities, a participation in TPs provides access to additional facilities and equipment, opens opportunities for creating new labour rates for their staff, and involves students in the research process[1].

Experience of Designing and Implementation of a University Technology Platform

The new generation of managers, engineers, and economists will have to deal with the challenges brought about by the rapidly changing world and participate in the technological breakthrough and tough competition for new markets. This generation will have to solve fundamentally different problems, which means that there will be

[1] Connecting Universities to Regional Growth: A Practical Guide. (2011). Retrieved from: URL: http://ec.europa.eu/regional_policy/sources/docgener/presenta/universities2011/universities2011_en.pdf (date of access: 11.11.2015).

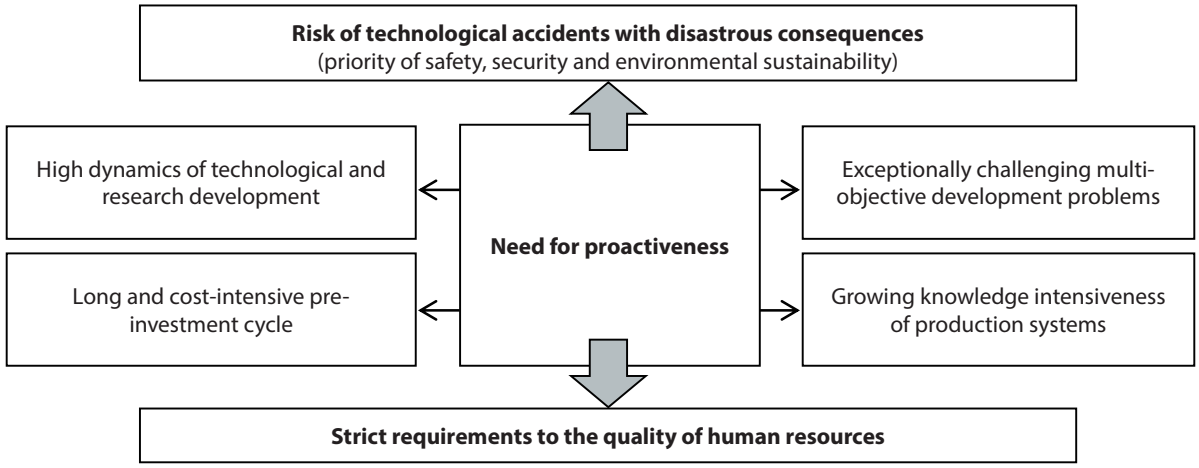

Fig. 4. *Features of power engineering and high-tech industries*

a shortage of qualified staff to handle these challenges efficiently.

What comes to the fore is a set of such skills and competencies as:

— feeling of context and being able to process diverse information quickly;

— investment attraction;

— creation of original methods of solving exceptionally challenging problems;

— conceptual engineering;

— organization of innovation processes and team work;

— project management;

— being ready for calculated risk.

A sustainability of the competitive advantages of a manager is determined by the manager's ability to simultaneously keep in sight their ongoing operations, monitoring their efficiency, and, to a greater extent, the prospective (future) challenges, which must be taken care of in advance. These characteristics of a modern manager enable him or her to be proactive: to adapt to a new situation faster than their competitors, to forecast its development, and to master new problem-solving tools.

As a result, there is a demand not only for totally new competencies but also for the change in the content of educational programs and cardinally different methods of their creation. 'Anticipatory learning' is understood here as an organized process of the formation of knowledge and competencies to deal with the problems and challenges of the future and, therefore, to meet the global trends and national development programs.

The described problem is crucial for the technological modernization of national economy and new industrialization of the country. What is more, it is so multidimensional that it might serve as a good reason for the creation of a special TP. Such TP is targeted at coordinating and integrating efforts of the triad 'science — education — business' to work towards one single goal: competence with proactive actions to surpass rivals and create the corresponding mechanism and tools. Furthermore, this TP was originally designed with due regard to the existing peculiarities of energy engineering and high-tech industries, as shown in Fig. 4, which required a drastic correction of the whole educational paradigm.

At the moment, the Ural Federal University is implementing a project for the establishment and development of TP for anticipatory learning, focused on achievements in the sphere of cutting-edge technological research[1]. The scheme of the platform structure is shown in Fig. 5.

The idea of creating such TP is new because the educational process and the opportunities for its improvement have never before been considered as a key research object within the TP frameworks[2].

The design of such TP was based on the following principles (see Table 3).

One of the TP's main features is that it is meant to intensify innovation processes in business and integrate them with the students' anticipatory learning curve together with the upgrading specialists' skills and competencies for working with the corporate reserve. This will prepare the busi-

[1] The establishment of this independent platform initiated by the research and education center «ENGEC», UrFU.

[2] The only example here is perhaps the 'National Platform of Open Education', which was established by the Ural Federal University in 2014 and was supported by the Russian Ministry of Education. This initiative is a long-term project, which involves combined investments made by universities to develop the educational technologies and accompanying IT-services to develop the network forms of educational programs based on on-line courses. Any university can include an on-line course as a mandatory or optional course in its curriculum on any level. The cost of the maintenance and development of the platform is distributed among the universities.

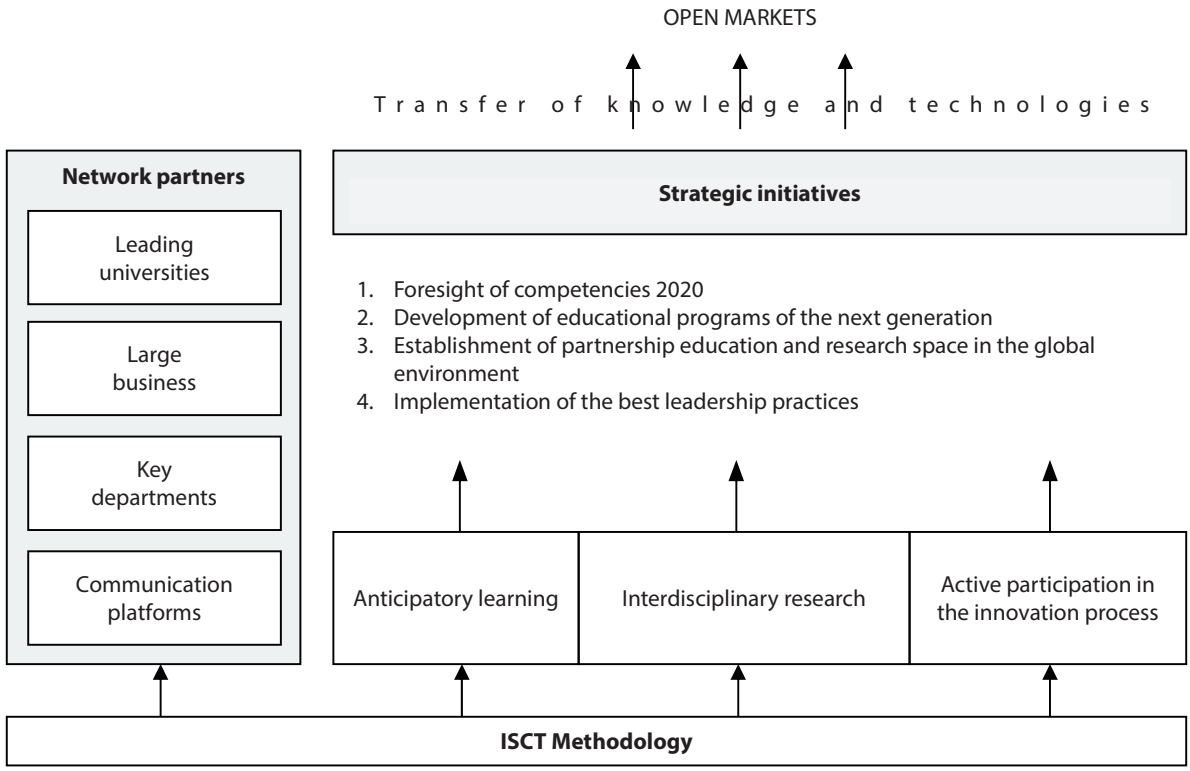

Fig. 5. *The structure of TP for anticipatory learning*

Table 3

Principles of a Technology Platform Design for Anticipatory Learning

Principles	Implementation Tools
Anticipatory learning, proactive actions	Organization of constant monitoring of the future and preparation of management systems for changes
Integration of education processes, human resources development and innovation implementation in each of the 'triad's' subjects	ISCT Methodology
Application of the best practices and expert knowledge in the global space	Network of the leading universities and business
Focussing of interdisciplinary research on connecting advanced industry-based technologies with competencies of the future	Context analysis

ness to face the challenges of the future and the university to keep up with the times and handle the important problems of production development by persistently improving the quality of its education services. As for science, it will have to forecast structural changes in the real sector and the competencies, which will be in greater demand in the future.

This launches the mechanism of self-development driven by specialists of the new formation, for whom the vision of the future and the ability to be proactive in order to provide a sustainable competitive edge become the core competences. It is important to point out that this principle applies to each element of the triad 'science — education — business'.

Let us describe some examples of interdisciplinary studies carried out within TP.

1. Methods of designing the future. Knowledge to form the vision of the future.

2. Modernization of educational programs based on the anticipatory learning paradigm and the foresight of competences.

3. Management of corporate environment generating new knowledge and innovations.

4. Development of methodology for individual professional anticipatory learning.

A key research area, that is, designing the future, is carried out in a specially created laboratory targeted at:

— context analysis: analytical reports about the global, national, regional, and industry-specific trends;

— development of technology for self-designing of the future (university, business structure, industry, area);

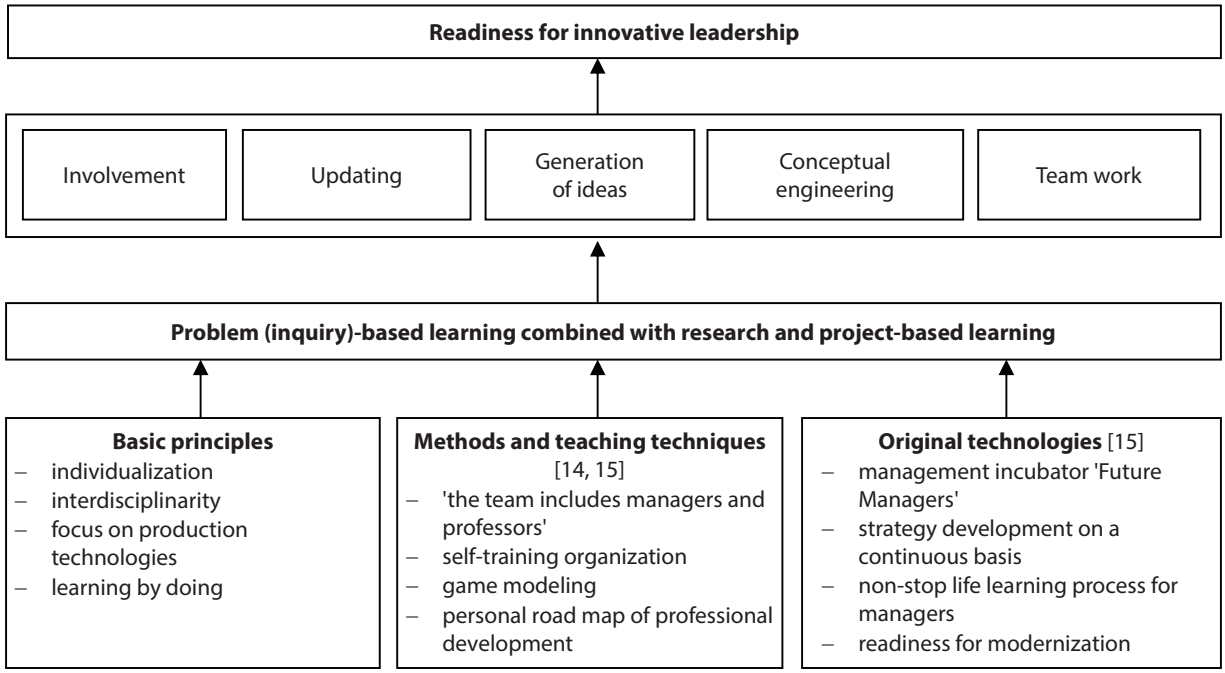

Fig. 6. *Characteristics of the ISCT Methodology*

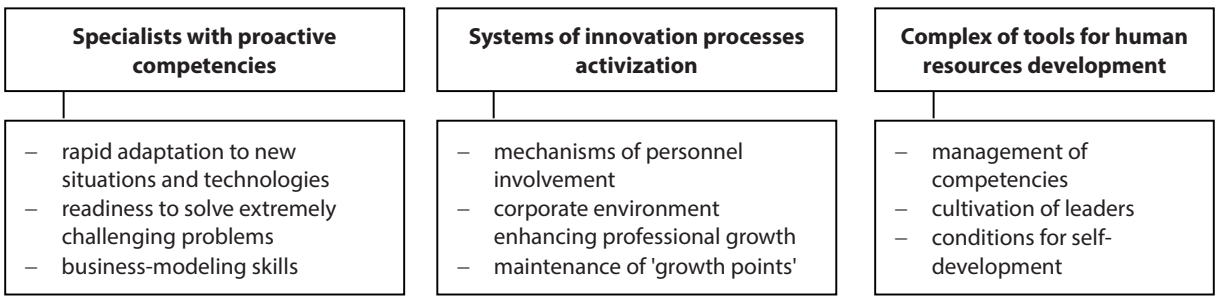

Fig. 7. *Products of the Anticipatory Learning Platform*

— creation of a system of continuing foresight forecasting.

The ideology underlying partnership relations between the business and the university in TP is the methodology 'ISCT' (Fig. 6), which comprises methods and technologies enhancing active immersion of students in the problem-solving environment, in which the research, project engineering, and interaction with experts and consultants take place. This model of learning is cardinally different from the traditional one. Professors organize the process of learning but also play the roles of a consultant and a moderator. Students engage in active discussions, share information, and cooperate to model and analyze situations. Learning is no longer focused on what is being said by the professor, rather on what the student is doing while working on the project. Students consider courses not as abstract scientific disciplines but as a hands-on experience contributing to solving real-life problems.

As the experience shows, ISCT presents a unique way of adapting the content of education to managers' real needs: realization of the activity approach, which enhances knowledge acquisition; development of proactiveness and responsibility; organization of teamwork; generation of new ideas, concepts, and stimulation of students' readiness to implement them.

Interdisciplinarity in ISCT is provided by the courses, which will integrate technology, ecology, economics, finance, investment, and management; organizational and activity-related games; problem-centred seminars involving two or three tutors specializing in different fields of knowledge; complex innovation projects.

The results of the TP's work: complementary products of an efficient partnership between university, science, and business (Fig. 7). It is important to emphasize their complementarity and their importance in all three elements of the triad. Therefore, TP described in this article plays an exceptional role of an integrated project enhancing

its participants' competitiveness and leadership abilities.

Conclusion

1. A technology platform is a powerful organizing, conceptual, and methodical tool applied to address complex interdisciplinary problems, which require strategic process organization; involvement of many experts; and generation of new knowledge, competencies, and investment resources.

TPs are orientated towards the creation of new cutting-edge innovations, which determine the appearance of new product niches, future markets, industrial scientific and technological achievements.

2. TP is a self-developing mechanism, which integrates advanced knowledge and the best practices of management systems improvement.

Unlike other elements of innovative infrastructure, which have been gaining popularity recently (centres of competence, centres of excellence, expert and analytical centres, innovation hubs and so on), TP is primarily a decentralized communication network with its participants sharing the same methodology and tools.

3. The concept of the presented TP is based on the idea of an interdisciplinary approach to learning that allows to train new formation specialists (both managers and engineers), with a wide range of sought-after competencies: knowledge of technologies, their relationship with the economy of high-tech industries, readiness to provide rapid response to new challenges of the environment and proactive actions.

4. The central task of a university's anticipatory learning TP is training specialists for the country's modernization and re-industrialization. To meet this target in modern conditions, it is essential to create in the global environment a research and education space, which would be based on a network model of the leading universities' international cooperation, advanced business structures, various communication platforms, and the constant influx of the talented youth. It should be noted that the dynamics of this process depends also on the development of innovative infrastructure of the Ural Federal University — circuit, which contributes to the rapid and efficient integration of advanced scientific and technological achievements in the educational process.

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